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Lamp for sunshine simulation

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Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 November 2016 (24.11.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/184852 A1

(51) International Patent Classification:
A61N 5/06 (2006.01) *F21S 8/00* (2006.01)

(21) International Application Number:
PCT/EP2016/061017

(22) International Filing Date:
17 May 2016 (17.05.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PA201500295 16 May 2015 (16.05.2015) DK

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,

[Continued on next page]

(54) Title: LAMP FOR SUNSHINE SIMULATION

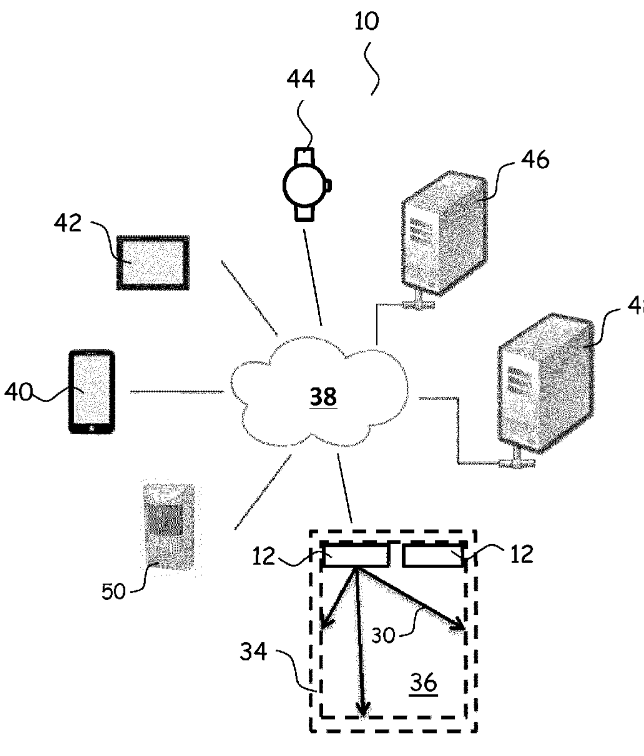

Fig. 3

(57) Abstract: A lamp system is provided, comprising a lamp with a lamp housing accommodating a plurality of light sources for emission of visible light, including blue light, a time keeping unit, a light sensor for sensing intensity of light incident upon it, and a light controller configured for controlling the plurality of light sources in response to the intensity of light sensed by the light sensor and the time provided by the time keeping unit, characterized in that the lamp emits blue light for a selected time period, wherein the blue light has a luminous flux ranging from 50 lux to 200 lux and, preferably, an irradiance that is larger than 5 $mW/nm/m^2$ in a selected wavelength range, such as in the wavelength range from 440 nm to 500 nm, as measured at a distance of 3 metres from the lamp.

WO 2016/184852 A1

TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

LAMP FOR SUNSHINE SIMULATION

FIELD OF THE INVENTION

A method of illuminating a room is provided; and a lamp, a lamp system, and a lamp controller operating according to the method are provided.

BACKGROUND OF THE INVENTION

It is well known that individuals living and working indoor may increase their well-being and productivity if they are exposed to an increased amount of daylight illumination.

Low energy and low spirit are some of the common symptoms of lack of exposure to daylight, and more severe symptoms also occur, such as depression, sleep disorders and shift-work disorders, etc.

Energy level and spirit of humans are influenced by various hormones, for example serotonin and melatonin. Lack of serotonin may lead to psychiatric disorders, such as polar, bi-polar and post-partum depression, etc. The hormone melatonin influences the human circadian rhythm. Like serotonin, melatonin is also related to different types of depressions. Winter depression is one example of how the human organism can respond to an imbalance of the two hormones.

Lamps that emit light with a spectrum similar to the spectrum, or part of the spectrum, of visible light emitted by the sun are well known. In recent years, in particular blue light sources, systems comprising such sources, and wearables monitoring and recommending on blue light exposure have gained interest mainly due to the fact that blue light affects the circadian rhythm. The eyes contain photoreceptors with high sensitivity to blue light, and these photoreceptors regulate melatonin ("sleep hormone") and serotonin (known as the "happiness" hormone).

In the present context, by a blue light source is meant a source with a relatively large amount of energy in the blue part of the spectrum (compared to the red part of the spectrum). This is to be understood in a broad sense as both a light source emitting light only within the blue spectrum, as well as a light source emitting light within the blue spectrum as well as within other ranges of the visible spectrum.

SUMMARY OF THE INVENTION

There is a need for lamps and lamp systems capable of adjusting light emission in response to changes to daylight conditions and/or behaviour of one or more persons benefitting from the emitted light.

Accordingly, a lamp system is provided that comprises a lamp (or light fitting) with a lamp housing accommodating a plurality of light sources for emission of visible light, including blue light,

a time keeping unit,

a light sensor for sensing intensity of light incident upon it, and

a light controller configured for controlling the plurality of light sources in response to the intensity of light sensed by the light sensor and the time provided by the time keeping unit.

Blue light has a wavelength ranging from 430 nm to 540 nm.

Preferably, the emission from the lamp or light fitting includes blue light having a wavelength in the wavelength range from 440 nm – 500 nm, preferably from 450 nm – 490, preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm.

Preferably, the emission from the lamp or light fitting includes blue light with a luminous flux ranging from 50 lux to 200 lux, preferred from 75 lux to 150 lux; more preferred around 100 lux, at a distance of 3 metres from the lamp during a selected time period. It has been shown that blue light with a luminous flux ranging from 50 lux to 200 lux, preferred from 75 lux to 150 lux, more preferred around 100 lux, at the eyes of a human has a significant effect on the circadian rhythm and also increases the productivity of the human.

Preferably, blue light received at the eyes of the human has an irradiance that is larger than 5 $mW/nm/m^2$, preferably in the wavelength range from 440 nm to 500 nm, preferred from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm.

A method of increasing human work productivity is provided; comprising the step of illuminating the eyes of the human with blue light with a luminous flux at the eyes ranging from 50 lux to 200 lux, preferred from 75 lux to 150 lux, more preferred around 100 lux, for a selected time period.

A method of increasing human work productivity is provided; comprising the step of illuminating the eyes of the human with blue light for a selected time period, wherein the blue light has an irradiance that is larger than 5 $mW/nm/m^2$, preferably in the wavelength range from 440 nm to 500 nm, preferred from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm.

A method of adjusting a circadian rhythm of a human is provided; comprising the step of illuminating the eyes of the human with blue light with a luminous flux at the eyes ranging from 50 lux to 200 lux, preferred from 75 lux to 150 lux, more preferred around 100 lux, for a selected time period.

A method of adjusting a circadian rhythm of a human is provided; comprising the step of illuminating the eyes of the human with blue light for a selected time period, wherein the blue light has an irradiance that is larger than 5 $mW/nm/m^2$, preferably in the wavelength range from 440 nm to 500 nm, preferred from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm.

For example, the method may comprise the step of selecting a start time of the time period of illuminating the eyes of the human with blue light that is 24 hours subsequent to a previous start time with a selected time interval, e.g. 30 minutes, added to or subtracted from the 24 hours, thereby effectively changing the circadian rhythm of the human, e.g. having travelled long distance by airplane to a location with a large time difference, e.g. 6 hours.

The lamp or light fitting may also emit visible light outside the wavelength range of blue light.

For example, the plurality of light sources may include blue light diodes and red and/or green and/or white light diodes, and the light controller may be configured to control the light diodes so that the lamp or light fitting emits light with a desired spectrum, e.g. perceived to be white light by a human.

Preferably, during a selected time period, the lamp or light fitting emits light with a total luminous flux at a distance of 3 metres from the lamp ranging from 100 lux to 1000 lux, preferably from 200 lux to 800 lux, preferred from 300 lux to 700 lux, more preferred from 400 lux to 600 lux, and preferably including blue light with a luminous flux and/or irradiance as explained above.

Preferably, during a selected time period, one or more light sources of the lamp or light fitting may emit light with a colour temperature ranging from 2000 K to 8000 K, preferably from 3000 K to 7000 K, more preferred from 4000 K to 6000 K.

Preferably, during a selected time period, the lamp or light fitting emits blue light with an irradiance that is larger than 5 $mW/nm/m^2$, preferably in the wavelength range from 440 nm to 500 nm, preferred from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm.

The lamp or light fitting may be configured for mounting proximate, or at, and/or attached to, a frame of a window, for example attached to the frame of the window, the window being mounted in a wall of a room for daylight illumination of the room through the window pane.

The proximity of the lamp or the light fitting to the window, preferably the distance is less than 50 cm, preferred less than 25 cm, more preferred less than 10 cm, most preferred less than 5 cm, causes the light emitted by the lamp or light fitting to be perceived as a part of the natural daylight illuminating the room through the window pane. In particular for elderly or individuals in mentally challenged circumstances, the perception of alienating or intruding technology may have a negative or sub-optimum effect.

The plurality of light sources may be mounted in the lamp housing so that the frame of the window is illuminated by the light sources and the room is illuminated by light from the lamp that has been reflected, e.g. diffusely reflected, into the room by the frame of the window. For example, each light source of the plurality of light sources may be mounted in the lamp housing so that a centre part of the light emitted by the light source is directed towards a part of the frame when the lamp is mounted in its intended position for use, whereby light emitted by the lamp is reflected by the frame of the window for illumination of the room in combination with sunlight entering the room through the window pane. The illuminated parts of the frame may be coated with a reflective material for improved illumination of the room.

Different light sources of the plurality of light sources may be mounted in the lamp housing for emission of light along different centre directions of propagation for illumination of different parts of the frame of the window also illuminated by sunlight at respective different times during a day.

Different light sources of the plurality of light sources may be mounted in the lamp housing for emission of light along different centre directions of propagation, wherein each of the different centre directions of propagation is equal to a direction of propagation of sunlight reflected by the frame at a respective time of day when the lamp is mounted in its intended position for use.

For example, various groups of light sources of the lamp or light fitting may be arranged for emission of light in different respective directions for illumination of different respective parts of the frame of the window illuminated by the sun at various angles of incidence of sunlight during the day, and the groups of light sources may be individually turned on and off in a sequence that corresponds to the changing angle of incidence of sunlight as a function of time.

The lamp or light fitting may comprise a diffuser so that the lamp of light fitting emits diffused light for uniform illumination of the room.

The lamp or light fitting may comprise one or more optical elements, such as lenses, lens arrays, micro-lenses, micro-lens arrays, reflectors, diffractive optical elements, etc., positioned in respective propagation paths of light emitted by the plurality of light sources for directing the emitted light into desired directions, e.g. thereby preventing or minimizing the amount of light emitted out of the window and the room.

The lamp or light fitting may be configured to be attached to a part of the frame of the window, e.g. of the frame that is attached to a wall and that supports the remaining parts of the window including the window pane.

The lamp or light fitting may be configured to be attached to the wall supporting the frame of the window in such a way that the lamp or light fitting is mounted to the wall proximate the window.

The lamp or light fitting may comprise mounting brackets for attachment to the wall or the frame of the window by well-known mechanical fasteners, such as screws, bolts, wall plugs, such as rawlplugs, etc.

The lamp or light fitting may be glued to the wall or the frame of the window.

The lamp or light fitting may comprise a surface with an adhesive for mounting of the lamp or light fitting in an easy and convenient way, e.g. to a wall proximate the window; or, to a part of the frame of the window, such as a top part of the frame of the window, or to the window ledge, etc.

The lamp or light fitting may have an elongate shape, e.g., with a length that corresponds to the width of the window, or, with a length that is less than half the width of the window, so that two lamps may be mounted end to end in one window. A set of two lamps will advantageously fit into windows of different widths larger than twice the length of one lamp.

Each of the light sources, or some of the light sources, and/or one or more groups of light sources, of the plurality of light sources may be individually controlled in such a way that the combined light emitted by the lamp or light fitting has a desired spectrum of a desired intensity, preferably, in combination with the sun light entering the window.

For example, around noon on a summer day with good weather conditions, the room may be sufficiently illuminated by sun light so that the lamp or light fitting is automatically turned off, whereas during a winter day with bad weather conditions, the room may receive very little sun light and the lamp or light fitting is automatically controlled to emit light with a spectrum similar to the visible spectrum of sun light and with a high intensity as a function of time of day so that the resulting illumination of the room will correspond to the illumination of a bright day.

In the morning, the plurality of light sources may be controlled to emit light that is perceived cold bluish and may have a colour temperature of around 6000 Kelvin and in the evening, the plurality of light sources may be controlled to emit light that is perceived reddish and may have a colour temperature of around 2000 Kelvin.

The lamp or light fitting may also comprise one or more ultraviolet light sources for emission of ultraviolet light, preferably in the UVB range from 290 nm to 330 nm, such as from 290 nm to 315 nm, such as from 290 nm – 300 nm. Human bodies exposed to ultraviolet light increase their production of vitamin D.

The ultraviolet light emitted by the lamp or light fitting may supplement sun light entering the room through the window pane so that the resulting light illuminating the room has a ultraviolet spectrum similar to the spectrum of ultraviolet sunlight, e.g. by supplying the part of the ultraviolet light that is prevented from entering the room through the window by the optical filtering of the material of the window pane.

The ultraviolet light may be emitted intermittently for control of the amount of exposure to ultraviolet light.

The ultraviolet light emitted by the lamp or light fitting may be adjusted to an optimum wavelength in the wavelength range from 290 nm to 330 nm, preferably from 290 nm to 315 nm, preferred from 290 nm – 300 nm, for the production of vitamin D in a human body.

Preferably, a human should receive about 500 Joule/m^2 – 750 Joule/m^2 per day, preferably 600 Joule/m^2 – 650 Joule/m^2 per day, for example by receiving 0.4 W/m^2 for 25 minutes per day which is equal to 600 Joule/m^2 per day.

However, preferably, the amount of ultraviolet light received per day is adjusted in response to skin colour as exemplified below:

Skin tone	Duration
Pale white	15 min
Fair	25 min
Medium	35 min
Dark brown	45 min
Black	60 min

The light controller may be configured for control of one or more parameters of the plurality of light sources, such as turn-on, turn-off, output power, intensity, intensity at one or more selected wavelengths, wavelength spectrum, colour temperature, etc.

For example, the light controller may be configured for control of one or more lamps or light fittings, e.g. attached proximate to respective one or more windows.

The light controller may comprise a processor that is configured for control of the one or more parameters of the plurality of light sources of one or more lamps or light fittings, e.g. by execution of software residing in one or more memories connected to the processor.

The light controller may comprise one or more inputs for connection with respective one or more sensors for inputting signals from the one or more sensors to the processor.

The one or more sensors may comprise a light sensor that is configured for sensing light intensity of light incident on the sensor, e.g. in a specific wavelength range; or, as a function of wavelength, for example a photoresistor, a photodiode, a phototransistor, etc.

One or more light sensors may be mounted for sensing intensity of natural daylight, e.g. on the outside of a building. The building may have a plurality of windows, each of which has one or more lamps mounted to it, wherein each of the lamps is controlled by the light controller in response to the intensity of the natural daylight outside the building as sensed by the one or more light sensors.

One or more light sensors may be mounted inside a room illuminated through a window that has one or more lamps mounted to it, wherein the one or more light sensors is/are mounted for sensing of the daylight entering the window without sensing light emitted by the one or more lamps, and wherein the one or more lamps is/are controlled by the light controller in response to the intensity of the natural daylight entering the window as sensed by the one or more light sensors.

The room may have a plurality of windows, each of which has one or more lamps mounted to it, and the one or more light sensors may be mounted for sensing daylight entering one of more of the windows without sensing light emitted by the one or more lamps, and each of the lamps may be controlled by the light controller in response to the intensity of the natural daylight entering one or more of the windows as sensed by the one or more light sensors.

The one or more light sensors may be positioned for sensing daylight in combination with light emitted by the one or more lamps or light fittings, and the light controller may be configured for controlling the one or more lamps or light fittings in response to the intensity of the combination of daylight and light emitted by the one or more lamps or light fittings as sensed by the one or more light sensors.

The light controller may be configured to, e.g. individually, control one or more lamps or light fittings mounted for illumination of one or more rooms so that the intensity of light illuminating the one or more rooms varies as a function of time of day, e.g. corresponding to, or in the same way, as the intensity of daylight varies relatively during a day, e.g. having a colour temperature corresponding to the colour temperature of sunlight at a selected time of day, e.g. at the current time of day, e.g. at the current date of the year; or, at a selected date of the year, such as the autumnal equinox or the spring equinox.

The light controller may be configured to control, e.g. individually, one or more or all of the lamps or light fittings mounted for illumination of one or more rooms so that the visible spectrum of the combined daylight having entered the room and the light emitted by the one or more lamps of light fittings has a desired shape, or substantially a desired shape, e.g. with a desired flux of blue light and/or irradiance of blue light and/or having the colour temperature of sunlight, e.g. at a selected time of day; e.g. at the current time of day, e.g. at the current date of the year; or, at a selected date of the year, such as the autumnal equinox or the spring equinox.

The light controller may be configured to control, e.g. individually, one or more or all of the ultraviolet light sources to emit ultraviolet light with an irradiance ranging from 0.005 W/m^2 – 0.8 W/m^2, preferably from 0,01 W/m^2 – 0,7 W/m^2, preferred from 0,05 W/m^2 – 0,6 W/m^2, more preferred 0,1 W/m^2 – 0,5 W/m^2, more preferred from 0,3 W/m^2 – 0,4 W/m^2, preferably measured at a distance ranging from 50 cm to 300 cm, preferred from 100 cm to 200 cm.

The lamp system may comprise one or more movement sensors for sensing human movement in a room accommodating one or more of the movement sensors, and wherein the light controller is configured for controlling the plurality of light sources of one or more lamps or light fittings in a room in response to the amount of movement sensed by the one or more movement sensors accommodated in the room.

The lamp system may comprise one or more personal health sensors configured to be worn by a human and sensing at least one health parameter, e.g. selected from the group consisting of body temperature, skin conductivity, heart rate, and blood pressure, and wherein the light controller is configured for controlling the plurality of light sources of one or more lamps in response to parameter values sensed by one or more personal health sensors.

The lamp system may comprise one or more personal environment sensors configured to be worn by a human, e.g. selected from the group consisting of accelerometer, gyroscope, compass, ambient light sensor, UV sensor, GPS-unit, and barometer, and wherein the light controller is configured for controlling the plurality of light sources of one or more lamps in response to parameter values output by one or more personal environment sensors.

The lamp system may for example be interconnected with wearables used by a human, such as smart phones, smart watches, such as the Apple Watch, the Samsung Gear, the Pebble Watch, etc., activity trackers, such as the Fitbit Flex and others by Fitbit, the Garmin Vivofit or others by Garmin, the Sony Smartband or others by Sony, etc., etc., utilizing data from their sensors, typically including an ambient light sensor, GPS, an accelerometer, a clock, etc.

The light controller may be configured for controlling the plurality of light sources of one or more lamps in response to personal data of one or more humans, such as age, eye colour, chronotype (morning/evening person), etc.

The light controller may be configured to turn-on and turn-off various groups of light sources of the lamp or light fitting that are arranged for emission of light in different respective directions. For example, the light controller may be configured for individually turning various groups of light sources on and off in a sequence so that the changing directions of light from the lamp having been reflected by the frame of the window the room correspond to the changing angle of incidence of sunlight as a function of time of day.

The lamp housing may accommodate one or more of the light sensors, e.g. a plurality of light sensors, e.g. two light sensors, and the light controller may be configured to control the lamp or light fitting in response to the intensity of light as sensed by the one or more light sensors.

The lamp housing may accommodate the light controller.

The lamp housing may further accommodate a control element, such as a knob, one or more keys, a switch, a slider, etc. for human adjustment of the intensity of light currently emitted by the lamp or light fitting. Subsequent to an adjustment, the light controller may continue to vary the intensity of light illuminating the room in the same way, relatively, as before adjustment.

The light controller may be accommodated in a housing separate from the lamp housing of the lamp or light fitting. For example, the light controller may reside in a separate room of a building comprising a plurality of rooms, each of which is illuminated with one or more of the lamp or light fitting that are controlled by the light controller, e.g. in response to light intensity as sensed by one or more light sensors as described above and possibly, or instead, in response to the time of day.

Alternatively, the light controller may reside in another building than the building with rooms illuminated with one or more of the lamp or light fitting.

The light controller may be interconnected with one or more lamps or light fittings with cables containing signal lines for provision of control signals from the light controller to the respective one or more lamps or light fittings.

The light controller may be wirelessly interconnected with one or more lamps or light fittings for wireless transmission of control signals from the light controller to the respective one or more lamps or light fittings.

For example, each of the light controller and one or more of the lamps or light fittings, time keeping units, light sensors, other sensors, and user interfaces, may comprise an interface to a wired Local-Area-Network (LAN) and/or a wireless LAN (BlueTooth, WiFi), and/or a mobile telephone network (3G, 4G) and/or another Wide-Area-Network (WAN), such as the internet. In this way networks already present may be utilized for interconnection of lamps and light fittings and time keeping units and light sensors and other sensors and user interfaces and the light controller and other parts of the lamp system; and thus, the light controller may receive inputs and control one or more of lamps or light fittings as desired utilizing existing network connections. Further, utilizing a WAN, such as the Internet, makes it possible for lamps and light fittings and time keeping units and light sensors and other sensors and user interfaces and the light controller and other parts of the light system to reside in separate locations possibly separated by large distances. For example, the light controller may reside on a server, or may be distributed among a plurality of servers, connected to the Internet and thus residing anywhere in the world in a location with Internet access.

The lamp system may comprise a hand-held unit that is configured for connection to the light controller and has a user interface configured for user entry of user data, and wherein the hand-held unit is configured to transmit the user data to the light controller, and wherein the light controller is configured for controlling the plurality of light sources in response to the user data.

The hand-held unit may be a smartphone or a tablet or a wearable computer, such as a smartwatch, an activity tracker, etc., and may have an interface to a wired Local-Area-Network (LAN) and/or a wireless LAN (BlueTooth, WiFi), and/or a mobile telephone network (3G, 4G), and/or a Wide-Area-Network (WAN), such as the internet, and may be configured to be interconnected with a remote server through the network, e.g. for storage of data from sensors of the hand-held unit, for entry of user data, etc.

Through the Wide-Area-Network, e.g. the Internet, the light controller may have access to data, such as personal health data and/or electronic time management and/or data provided by communication tools relating to and used by one or more users of the lamp or light fitting. The tools and the stored information typically reside on one or more remote servers accessed through the Wide-Area-Network. A plurality of devices, e.g. users' smartphones, with interfaces to the Wide-Area-Network may access the one or more remote servers through the Wide-Area-Network and may be used to enter information relating to the users.

The tools may include electronic calendar system(s), email system(s), such as Microsoft Outlook, Windows Mail, Mozilla Thunderbird, Apple Mail, Opera Mail, Hotmail, Gmail, etc., social network(s), professional network(s), such as Facebook ®, LinkedIn ®, Google+, Twitter, MySpace, etc., well-known for management of appointments and other daily activities and communications.

The light controller, or a part of the light controller, may reside on the hand-held unit.

A user interface for the lamp system may reside on a smartphone, and the smartphone may execute an app allowing the user to control the lamp system, e.g. for adjustment of one or more selected lamps or light fittings, selection of programs controlling parameters of light emitted by the one or more selected lamps as a function of time, etc.

The Wide-Area-Network may be accessed through a mobile telephone network, such as GSM, IS-95, UMTS, CDMA-2000, etc.

The data may include schedules of tasks to be performed, such as tournament days, competition dates, anniversaries, appointments, meetings, etc.

The lamp system may be used when driving, preferably, during morning hours for exposure of blue light and/or UVB light to an individual's eyes. Preferably, the lamp is positioned in proximity or adjacent to a sun visor of a car, alternatively the lamp is attached directly to a sun visor or a car. Preferably, the lamp emits a broad spectrum of light providing a white light perception of the user.

The lamp system may be used by an athlete during training periods and/or for competitions. It is an advantage that the lamp system enables the athlete to optimize sleep during intense training and/or competition programs. This is important as sleep is a critical parameter for recovery, and an athlete's reaction speed and ability to perform at maximum level.

BRIEF DESCRIPTION OF THE DRAWINGS

Below, the method and the power converter are explained in more detail with reference to the drawings in which various resonant examples of the power converter are shown. In the drawings:

Fig. 1 shows a lamp configured to be mounted to a top part of a window frame,

Fig. 2 schematically illustrates a window with two lamps mounted to the window frame, and

Fig. 3 schematically illustrates a lamp system with parts of the system interconnected through a WAN.

DETAILED DESCRIPTION OF EMBODIMENTS

The accompanying drawings are schematic and simplified for clarity, and they merely show details which are essential to the understanding of the resonant power converter, while other details have been left out. The lamp system according to the appended claims may be embodied in different forms not shown in the accompanying drawings and should not be construed as limited to the examples set forth herein.

Like reference numerals refer to like elements throughout. Like elements may, thus, not be described in detail with respect to the description of each figure.

Fig. 1 shows a lamp or a light fitting 12 with a lamp housing 14 accommodating a plurality of light sources 16 for emission of visible light, including blue light. The lamp 12 also has a power supply (not shown) for supplying the plurality of light sources 16 and other circuitry of the lamp 12 with power. The power supply is connected to the mains for powering the lamp 12.

The plurality of light sources includes blue LEDs and white LEDs and the illustrated lamp 12 is capable of emitting white light with a luminous flux of 400 lux including blue light with a luminous flux of 100 lux and, preferably, with an irradiance that is larger than 5 $mW/nm/m^2$, preferably in the wavelength range from 440 nm to 500 nm, preferred from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm, when the luminous flux and irradiance are measured at a distance of 3 metres from the lamp.

The blue LEDs emit light with a centre wavelength of 465 nm and have a FWHM (full-width-half-maximum) of 25 nm. The white LEDs have a blue LED coated with a phosphor layer that emits Stokes-shifted light at about 500 – 700 nm.

The illustrated lamp 12 is configured to be attached pairwise to the left and right vertical sides, respectively, of a frame of a window that provides daylight illumination of a room.

Different groups of light sources 18, 20 of the plurality of light sources 16 are mounted in the lamp housing 14 for emission of light along different centre directions of propagation, wherein each of the different centre directions of propagation is equal to a direction of propagation of sunlight reflected by the frame of the window at a respective time of day when the lamp 12 is mounted in its intended position for use.

For example, one group of light sources 18 of the lamp 12 is tilted with respect to the other group of light sources 20 for emission of light in different respective directions for illumination of different respective parts of the frame of the window to emulate different angles of incidence of sunlight during the day, and the groups of light sources 18, 20 may be individually turned on and off in a sequence that corresponds to the changing angle of incidence of sunlight as a function of time.

The lamp housing 14 comprises a diffuser 22 and light emitted by the lamp is output through the diffuser 22 so that the lamp 12 emits diffused light for uniform illumination of the room.

The lamp 12 may comprise one or more optical elements (not shown), such as lenses, lens arrays, micro-lenses, micro-lens arrays, reflectors, diffractive optical elements, etc., positioned in respective propagation paths of light emitted by the LEDs for directing the emitted light into desired directions, e.g. thereby preventing emission of light, or minimizing the amount of light emitted, out of the window and the room.

The rear part 24 of the lamp 12 opposite the diffuser 22 is made of aluminium for heat dissipation and has a surface with an adhesive 26 for attachment of the lamp 12 in an easy and convenient way to the frame of the window without modifying the frame.

The lamp 12 has two light sensors 28 mounted in the diffuser 22 for sensing overall light intensity.

The lamp 12 may also comprise one or more ultraviolet light sources (not shown), e.g. ultraviolet LEDs, for emission of ultraviolet light, preferably in the UVB range from 290 nm to 380 nm, such as from 290 nm to 320 nm, such as from 300 nm – 320 nm, such as from 300 nm – 310 nm. Human bodies exposed to ultraviolet light increase their production of vitamin D.

The ultraviolet light emitted by the lamp or light fitting may supplement sun light entering the room through the window pane so that the resulting light illuminating the room has a ultraviolet spectrum similar to the spectrum of ultraviolet sunlight, e.g. by supplying the part of the ultraviolet light that is prevented from entering the room through the window by the optical filtering of the material of the window pane.

The ultraviolet light may be emitted intermittently for control of the amount of exposure to ultraviolet light.

The ultraviolet light emitted by the lamp or light fitting may be adjusted to an optimum for the production of vitamin D in a human body.

The light controller may be configured to control, e.g. individually, one or more or all of the ultraviolet light sources to emit ultraviolet light with an irradiance ranging from 0.005 W/m^2 – 0.8 W/m^2, preferably from 0,01 W/m^2 – 0,7 W/m^2, preferred from 0,05 W/m^2 – 0,6 W/m^2, more preferred 0,1 W/m^2 – 0,5 W/m^2, more preferred from 0,3 W/m^2 – 0,4 W/m^2, preferably measured at a distance ranging from 50 cm to 300 cm, preferred from 100 cm to 200 cm.

The lamp 12 also comprises a time keeping unit (not shown) keeping track of the time of day and accommodated in the lamp housing 14.

The lamp 12 also comprises a light controller (not shown) accommodated in the lamp housing 14 and controlling the plurality of light sources 16 in response to the intensity of light sensed by the light sensors 28 and the time provided by the time keeping unit.

The light controller is configured for control of turn-on and turn-off of the blue and white LEDs and the intensity of the emitted light from the blue and white LEDs in response to the time provided by the time keeping unit.

Thus, the illustrated lamp 12 is a self-contained unit.

The lamp 12 housing may further accommodate a control element (not shown), such as a knob for human adjustment of the intensity of light currently emitted by the lamp 12. Subsequent to an adjustment, the light controller continues to vary the intensity of light in the same pre-determined way as before adjustment, e.g. if the light intensity has been lowered by 3 dB, the light controller will lower all intensities as function of time with 3 dB after the adjustment.

The light controller is configured to control the intensity of the emitted light as a function of time of day, e.g. corresponding to, or in the same way, as the intensity of daylight varies relatively during an equinox. Following the circadian rhythm of an equinox eliminates a need for the time keeping unit to keep track of dates thereby simplifying the time keeping unit and the light controller. Humans exposed to the illumination of the lamp 12 will also benefit from the fixed circadian rhythm.

For example, around noon on a summer day with good weather conditions, the room may be sufficiently illuminated by sun light so that the light controller turns the lamp 12 off, whereas during a winter day with bad weather conditions, the room may receive very little sun light and the light controller controls the LEDs 18, 20 of the lamp 12 to emit light with a spectrum similar to the visible spectrum of sun light and with a high intensity as a function of time of day so that the resulting illumination of the room will correspond to the illumination of a bright day.

In the morning, the light controller may control the LEDs 18, 20 to emit light that is perceived cold bluish and may have a colour temperature of around 6000 Kelvin and in the evening, the light controller may control the LEDs 18, 20 to emit light that is perceived reddish and may have a colour temperature of around 2000 Kelvin.

The lamp 12 may comprise, or be connected with, a movement sensor (not shown) for sensing human movement in the room and the light controller may be configured for controlling the LEDs in response to a signal from the movement sensor, e.g. the light controller may turn the LEDs off when no human presence is detected by the movement sensor.

Fig. 2 schematically illustrates two identical lamps 12, each of which having a lamp housing 14 accommodating a plurality of light sources (not visible) for emission of visible light 30, including blue light. Each of the lamps 12 also has a power supply (not shown) for supplying the plurality of light sources and other circuitry of the lamp 12 with power. The power supply is connected to the mains for powering the lamps 12.

The plurality of light sources includes blue LEDs and white LEDs and the illustrated lamp 12 is capable of emitting white light with a luminous flux of 400 lux including blue light with a luminous flux of 100 lux and, preferably, with an irradiance that is larger than 5 $mW/nm/m^2$, preferably in the wavelength range from 440 nm to 500 nm, preferred from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm, when the luminous flux and irradiance are measured at a distance of 3 metres from the lamp.

The blue LEDs emit light with a centre wavelength of 465 nm and have a FWHM (full-width-half-maximum) of 25 nm. The white LEDs have a blue LED coated with a phosphor layer that emits Stokes-shifted light at about 500 – 700 nm.

The illustrated lamps 12 are configured to be attached pairwise to left and right parts, respectively, of the horizontal top part 32 of a frame 34 of a window 36 that provides daylight illumination of a room (not shown).

The LEDs are mounted in the lamp housings 14 so that the frame 34 of the window 36 is illuminated by the LEDs and the room (not shown) is illuminated by light from the lamps 12 that has been reflected, e.g. diffusely reflected, into the room by the frame 34 of the window 36. For example, each LED is mounted in the lamp housing 14 so that a centre part of the light emitted by the LED is directed towards a part of the frame 34 when the lamp 12 is mounted in its intended position for use, whereby light 30 emitted by the lamps 12 is reflected by the frame 34 of the window 36 for illumination of the room in combination with sunlight entering the room through the window pane. The illuminated parts of the frame 34 may be coated with a reflective material for improved illumination of the room.

Different LEDs can be mounted in the lamp housing 14 for emission of light along different centre directions of propagation 30 for illumination of different parts of the frame 34 of the window 36 also illuminated by sunlight at respective different times during a day.

For example, various groups of LEDs of the lamps 12 may be arranged for emission of light in different respective directions 30 for illumination of different respective parts of the frame 34 of the window 36 also illuminated by the sun at various angles of incidence of sunlight during the day, and the groups of LEDs may be individually turned on and off in a sequence that corresponds to the changing angle of incidence of sunlight as a function of time.

The lamps 12 may comprise one or more optical elements (not shown), such as lenses, lens arrays, micro-lenses, micro-lens arrays, reflectors, diffractive optical elements, etc., positioned in respective propagation paths of light emitted by the LEDs for directing the emitted light into desired directions, e.g. thereby preventing emission of light, or minimizing the amount of light emitted, out of the window and the room.

The part 24 of the lamp housing 14 attached to the top part 32 of the frame 34 of the window 36 is made of aluminium for heat dissipation and has a surface with an adhesive 26 for attachment of the lamp 12 in an easy and convenient way to the frame 34 of the window 36 without modifying the frame 34.

Each of the lamps 12 has two light sensors 28 (not shown) mounted in the lamp housing 14 and facing the room for sensing overall light intensity.

Each of the lamps 12 may also comprise one or more ultraviolet light sources (not shown), e.g. ultraviolet LEDs, for emission of ultraviolet light, preferably in the UVB range from 280 nm to 380 nm, such as from 280 nm to 320 nm, such as from 300 nm – 320 nm, such as from 300 nm – 310 nm. Human bodies exposed to ultraviolet light increase their production of vitamin D.

The ultraviolet light emitted by the lamp or light fitting may supplement sun light entering the room through the window pane so that the resulting light illuminating the room has a ultraviolet spectrum similar to the spectrum of ultraviolet sunlight, e.g. by supplying the part of the ultraviolet light that is prevented from entering the room through the window by the optical filtering of the material of the window pane.

The ultraviolet light may be emitted intermittently for control of the amount of exposure to ultraviolet light.

The ultraviolet light emitted by the lamp or light fitting may be adjusted to an optimum for the production of vitamin D in a human body.

The light controller may be configured to control, e.g. individually, one or more or all of the ultraviolet light sources to emit ultraviolet light with an irradiance ranging from 0.005 W/m^2 – 0.8 W/m^2, preferably from 0,01 W/m^2 – 0,7 W/m^2, preferred from 0,05 W/m^2 – 0,6 W/m^2, more preferred 0,1 W/m^2 – 0,5 W/m^2, more preferred from 0,3 W/m^2 – 0,4 W/m^2, preferably measured at a distance ranging from 50 cm to 300 cm, preferred from 100 cm to 200 cm.

Each of the lamps 12 also comprises a time keeping unit (not shown) keeping track of the time of day and accommodated in the lamp housing 14.

Each of the lamps 12 also comprises a light controller (not shown) accommodated in the lamp housing 14 and controlling the plurality of light sources 16 in response to the intensity of light sensed by the light sensors 28 and the time provided by the time keeping unit.

The light controller is configured for control of turn-on and turn-off of the blue and white LEDs and the intensity of the emitted light from the blue and white LEDs in response to the time provided by the time keeping unit.

Thus, each of the illustrated lamps 12 is a self-contained unit.

Each of the lamp housings 14 may further accommodate a control element (not shown), e.g. a knob for human adjustment of the intensity of light currently emitted by the lamp 12. Subsequent to an adjustment, the light controller continues to vary the intensity of light in the same pre-determined way as before adjustment, e.g. if the light intensity has been lowered by 3 dB, the light controller will lower all intensities as function of time with 3 dB after the adjustment.

The light controller is configured to control the intensity of the emitted light as a function of time of day, e.g. corresponding to, or in the same way, as the intensity of daylight varies relatively during an equinox. Following the circadian rhythm of an equinox eliminates a need for the time keeping unit to keep track of dates thereby simplifying the time keeping unit and the light controller. Humans exposed to the illumination of the lamp 12 will also benefit from the fixed circadian rhythm.

For example, around noon on a summer day with good weather conditions, the room may be sufficiently illuminated by sun light so that the light controller turns the lamp 12 off, whereas during a winter day with bad weather conditions, the room may receive very little sun light and the light controller controls the LEDs 18, 20 of the lamp 12 to emit light with a spectrum similar to the visible spectrum of sun light and with a high intensity as a function of time of day so that the resulting illumination of the room will correspond to the illumination of a bright day.

In the morning, the light controller may control the LEDs 18, 20 to emit light that is perceived cold bluish and may have a colour temperature of around 6000 Kelvin and in the evening, the light controller may control the LEDs 18, 20 to emit light that is perceived reddish and may have a colour temperature of around 2000 Kelvin.

Each of the lamps 12 may comprise, or be connected with, a movement sensor (not shown) for sensing human movement in the room and the light controller may be configured for controlling the LEDs in response to a signal from the movement sensor, e.g. the light controller may turn the LEDs off when no human presence is detected by the movement sensor.

Fig. 3 schematically illustrates a lamp system 10 wherein various parts of the system 10 are interconnected through a Wide-Area-Network (WAN), namely the Internet. The illustrated lamp system 10 further utilizes cloud based services, e.g. for accessing data relating to the activities of a human.

As indicated in Fig. 3, the illustrated lamp system 10 may have lamps 12 with the same mechanical configuration with LEDs, and possibly ultraviolet LEDs, arranged in the same way as disclosed above with reference to Figs. 1 and 2. However, the electronic circuitry of the lamps 12 are different as explained in more detail below. The illustrated lamp system 10 may control the lamps 12 of the system in the same way as explained above with reference to Figs. 1 and 2, and time keeping units, light sensors, and other sensors may be positioned and connected in the system for cooperation in the same way as explained above with reference to Figs. 1 and 2.

The illustrated lamp system 10 may also comprise lamps of a different mechanical construction as is well-known in the field of light therapy, e.g. portable lamps (not shown) with blue LEDs, e.g. used during travelling.

The illustrated lamp system 10 comprises a plurality of lamps 12 (or light fittings), each of which having a lamp housing 14 accommodating a plurality of light sources (not shown) for emission of visible light, including blue light. Some of the lamps 12, or all of the lamps 12, may be mounted in different windows for illumination of different rooms of the same building; or, of different buildings. Some of the lamps 12, or all of the lamps 12, may be mounted in ceilings or may be positioned on the floor or on tables.

The light controller of the lamp system 10 and each of the lamps 12 comprise an interface to a wired Local-Area-Network (LAN) and/or a wireless LAN (BlueTooth, WiFi), and/or a mobile telephone network (3G, 4G) and/or another Wide-Area-Network (WAN), such as the Internet 38 for interconnection of the light controller with the lamps 12 through the network. In the illustrated example, the lamps 12 are connected with other parts of the lamp system 10 through the Internet 38. In this way, various parts of the lamp system 10, and other devices connected to the lamp system 10, may reside in any location remote from each other provided that the locations have access to the Internet 38. For example, the light controller may reside on a server 46, 48, or may be distributed among a plurality of servers 46, 48, connected to the Internet 38 and thus residing anywhere in the world in a location with Internet access.

Likewise, other parts of the lamp system 10, including time keeping units and light sensors and other sensors and user interfaces and the light controller, also have interfaces providing access to the Internet; and thus, the light controller may receive inputs and control one or more of lamps 12 as desired via the Internet 38.

One or more light sensors (not shown) may be mounted for sensing intensity of natural daylight, e.g. on the outside of a building. The building may have a plurality of windows, each of which has one or more lamps 12 mounted to it, wherein each of the lamps 12 is controlled by the light controller in response to the intensity of the natural daylight outside the building as sensed by the one or more light sensors.

One or more light sensors may be mounted inside a room illuminated through a window that has one or more lamps 12 mounted to it, wherein the one or more light sensors is/are mounted for sensing of the daylight entering the window without sensing light emitted by the one or more lamps 12, and wherein the one or more lamps 12 is/are controlled by the light controller in response to the intensity of the natural daylight entering the window as sensed by the one or more light sensors.

Some rooms may have a plurality of windows 36, each of which has one or more lamps 12 mounted to it, and the one or more light sensors may be mounted for sensing daylight entering one of more of the windows 36 without sensing light emitted by the one or more lamps 12, and each of the lamps 12 may be controlled by the light controller in response to the intensity of the natural daylight entering one or more of the windows as sensed by the one or more light sensors.

The one or more light sensors may be positioned for sensing daylight in combination with light emitted by the one or more lamps 12, and the light controller may be configured for controlling the one or more lamps 12 in response to the intensity of the combination of daylight and light emitted by the one or more lamps 12 as sensed by the one or more light sensors.

The light controller may be configured to, e.g. individually, control one or more lamps 12 mounted for illumination of one or more rooms so that the intensity of light illuminating the one or more rooms varies as a function of time, e.g. corresponding to, or in the same way, as the intensity of daylight varies during a day, e.g. having a colour temperature corresponding to the colour temperature of sunlight at a selected time of day, e.g. at the current time of day, e.g. at the current date of the year; or, at a selected date of the year, such as the autumnal equinox or the spring equinox.

The light controller may be configured to control, e.g. individually, one or more lamps 12 mounted for illumination of one or more rooms so that the visible spectrum of the combined daylight having entered the room and the light emitted by the one or more lamps of light fittings has a desired shape, or substantially a desired shape, e.g. with a desired flux and irradiance of blue light and/or having the colour temperature of sunlight, e.g. at a selected time of day; e.g. at the current time of day, e.g. at the current date of the year; or, at a selected date of the year, such as the autumnal equinox or the spring equinox.

The lamp housings 14 may accommodate a control element (not shown), such as a knob, one or more keys, a switch, a slider, etc. for human adjustment of the intensity of light currently emitted by the lamp 12. Subsequent to an adjustment, the light controller may continue to vary the intensity of light illuminating the room in the same way, relatively, as before adjustment.

The lamp system 10 comprises one or more hand-held units, each of which is configured for connection to the light controller and has a user interface configured for user entry of user data, and wherein the hand-held unit is configured to transmit user data to the light controller, and wherein the light controller is configured for controlling the plurality of light sources in response to the user data.

The hand-held unit may be a smartphone 40 or a tablet 42 or a wearable computer, such as a smartwatch 44, an activity tracker (not shown), etc., and has an interface to a wired Local-Area-Network (LAN) and/or a wireless LAN (BlueTooth, WiFi), and/or a mobile telephone network (3G, 4G), and/or a Wide-Area-Network (WAN), namely the internet, and may be configured to be interconnected with a remote server 46 through the Internet 38, e.g. for storage of data from sensors of the hand-held unit, for entry of user data, etc.

Through the Internet 38, the light controller may have access to data, such as personal health data and/or electronic time management and/or data provided by communication tools relating to and used by one or more users of the lamp 12. The tools and the stored information typically reside on one or more remote servers 46, 48 accessed through the Internet 38. A plurality of devices, e.g. users' smartphones 40, with interfaces to the Internet 38 may access the one or more remote servers 46, 48 through the Internet 38 and may be used to enter information relating to the users.

The tools may include electronic calendar system(s), email system(s), such as Microsoft Outlook, Windows Mail, Mozilla Thunderbird, Apple Mail, Opera Mail, Hotmail, Gmail, etc., social network(s), professional network(s), such as Facebook ®, LinkedIn ®, Google+, Twitter, MySpace, etc., well-known for management of appointments and other daily activities and communications.

The light controller, or a part of the light controller, may reside in a smartphone 40 or in a tablet 42.

The lamp system may comprise one or more movement sensors 50 for sensing human movement in a room accommodating one or more of the movement sensors 50, and wherein the light controller is configured for controlling lamps in a room in response to the amount of movement sensed by the one or more movement sensors 50 accommodated in the room.

The lamp system may comprise one or more personal health sensors configured, e.g. residing in a smart watch 44 and/or in an activity tracker and/or in a smartphone 40, to be worn by a human and sensing at least one health parameter, e.g. selected from the group consisting of body temperature, skin conductivity, heart rate, and blood pressure, and wherein the light controller is configured for controlling one or more lamps in response to parameter values sensed by one or more personal health sensors.

The lamp system may comprise one or more personal environment sensors, e.g. residing in a smart watch 44 and/or in an activity tracker and/or in a smartphone 40 and/or in a tablet 42, configured to be worn by a human, e.g. selected from the group consisting of accelerometer, gyroscope, compass, ambient light sensor, UV sensor, GPS-unit, and barometer, and wherein the light controller is configured for controlling one or more lamps in response to parameter values output by one or more personal environment sensors.

Through the Internet 38, the lamp system may be interconnected with wearables used by a human, such as smart phones, smart watches, such as the Apple Watch, the Samsung Gear, the Pebble Watch, etc., activity trackers, such as the Fitbit Flex and others by Fitbit, the Garmin Vivofit or others by Garmin, the Sony Smartband or others by Sony, etc., etc., utilizing data from their sensors as already mentioned, typically including an ambient light sensor, GPS, an accelerometer, a time keeping unit, etc.

A user interface of the lamp system 10 may reside in a smartphone 40 or in a tablet 42, and the smartphone 40 or tablet 42 may execute an app allowing the user to control the lamp system 10, e.g. for adjustment of one or more selected lamps 12, selection of programs controlling parameters of light emitted by the one or more selected lamps 12 as a function of time, etc. Various programs for control of lamps 12 in response to sensor data, personal data, date and time, and user commands entered with the user interface, may be downloaded to the smartphone 40 or tablet 42 and be selected for execution with the user interface.

The Internet 38 may be accessed through a mobile telephone network, such as GSM, IS-95, UMTS, CDMA-2000, etc.

The data may include schedules of tasks to be performed, such as tournament days, competition dates, anniversaries, appointments, meetings, etc.

In one lamp system 10, the light controller resides in a smartphone 40 and executes an app for control of lamps 12. The app has been downloaded from a remote server and updates may be regularly received from the server. The light controller controls the lamps 12 based on time in accordance with the circadian rhythm of an equinox, and based on sensor data, and based on planned activities as recorded in an electronic calendar residing on a remote server 46, 48 and accessed by the light controller.

The equinox is divided into time periods, namely 1) morning, 2) afternoon, and 3) evening and night. The sensor data are received form light sensors and wearables with GPS and activity trackers and movement sensors. Planned activities may include work, exercise, and education.

The light controller controls lamps 12 to emit light with a luminance of 400 lux including 100 lux of blue light (peak wavelength is 460 nm) and, preferably, with an irradiance that is larger than 5 $mW/nm/m^2$, preferably in the wavelength range from 440 nm to 500 nm, preferred from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm, at a distance of 3 metres from the lamp in question during the morning and afternoon before and during work or exercise or education.

The light controller turns lamps 12 off during the evening and night or when nobody is present in a room illuminated by the lamp 12 in question as detected by movement detectors and/or wearables or subsequent to a period with intense activities.

The table below illustrates operations of the light controller:

		Colour temperature	Intensity	Lamp mounting	P	Expected results
Standard periods	**Morning** (1 hr. prior awakening and before lunch)	Blue white 6000-7000 kelvin	Mediocre	Window Ceiling Table	2	Easy morning routine High activity
	Midday (Before and after lunch)	White 4000-5000 Kelvin	High	Window Ceiling Table	4	Increased appetite
	Evening (After dinner)	Yellowish 2700-3000 Kelvin	Mediocre	Ceiling Table	4	Low activity Undisturbed sleep
	Night (After bedtime)	Red 2000 Kelvin	High	Ceiling Table	2	Undisturbed sleep Fewer falls
Special	**Activity requiring high energy** **e.g. Training, daytrips etc.** (Controlled by caregivers)	Blue white 6000-7000 Kelvin	High	Window Ceiling Table	1	e.g. Higher training output from training
Area controlled	**Relaxing area activated** **e.g. Couch, leaning chair** (decided by elderly and caregivers)	Yellowish 2700-3000 Kelvin	Mediocre	Ceiling Table	3	Low activity Encourages relaxing
	Activity area activated **e.g. desk, dinner table etc.** (decided by elderly and caregivers)	White 4000-5000 Kelvin	High	Ceiling Table	3	Improved environment for doing difficult tasks Increased alertness, memory and focus

P = Priority.

a light controller configured for controlling the plurality of light sources in response to

The light controller may be configured to control the plurality of light sources in response to personal data of a human, such as age, eye colour, chronotype (morning/evening person), etc.

The table below illustrates how the light controller may operate to adjust illuminance in response to personal data:

Age	Eyes of dark colour		Eyes of bright colour	
	Morning person	**Evening person**	**Morning person**	**Evening person**
10 years old	180 lux	200 lux	135 lux	160 lux
25 years old	230 lux	280 lux	170 lux	200 lux
45 years old	400 lux	480 lux	300 lux	360 lux
65 years old	660 lux	800 lux	500 lux	600 lux
85 years old	800 lux	960 lux	600 lux	720 lux

CLAIMS

1. A lamp system comprising

a lamp with a lamp housing accommodating a plurality of light sources for emission of visible light, including blue light,

a time keeping unit,

a light sensor for sensing intensity of light incident upon it, and

a light controller configured for controlling the plurality of light sources in response to the intensity of light sensed by the light sensor and the time provided by the time keeping unit,

c h a r a c t e r I z e d in that

the lamp emits blue light with a luminous flux ranging from 50 lux to 200 lux at a distance of 3 metres from the lamp during a selected time period.

2. A lamp system according to claim 1, wherein the lamp emits blue light with an irradiance that is larger than 5 mW/nm/m^2 in a selected wavelength range, such as in the wavelength range from 440 nm to 500 nm preferably from 450 nm – 490, more preferred from 450 nm – 480 nm, more preferred from 450 nm – 470 nm, more preferred from 455 nm – 465 nm.

3. A lamp system according to claim 1 or 2, wherein the lamp housing is configured for attachment at a frame of a window and wherein each light source of the plurality of light sources is mounted in the lamp housing so that a centre part of the light emitted by the light source is directed towards a part of the frame when the lamp is mounted in its intended position for use, whereby light emitted by the lamp is reflected by the frame of the window for illumination of a room in combination with sunlight entering the room through the window.

4. A lamp system according to claim 3, wherein different light sources of the plurality of light sources are mounted in the lamp housing for emission of light along different centre directions of propagation for illumination of different parts of the frame of the window illuminated by sunlight at respective different times during a day.

5. A lamp system according to claim 1 or 2, wherein the lamp housing is configured for attachment at a frame of a window and wherein different light sources of the plurality of light sources are mounted in the lamp housing for emission of light along different centre directions of propagation, and wherein each of the different centre directions of

propagation is equal to a direction of propagation of sunlight reflected by the frame at a respective time of day when the lamp is mounted in its intended position for use.

6. A lamp system according to any of claims 3 – 5, wherein the lamp housing has a surface with an adhesive for attachment at the frame of the window.

7. A lamp system according to any of the previous claims, wherein the lamp housing accommodates the light sensor.

8. A lamp system according to any of claims 3 – 7, wherein the light controller is configured to control the plurality of light sources to emit light that in combination with the part of daylight having been transmitted through the window has a visible part of the spectrum with a desired shape.

9. A lamp system according to any of the previous claims, wherein the lamp housing comprises at least one ultraviolet light source for emission of ultraviolet light, preferably in the UVB range from 280 nm to 380 nm, such as from 280 nm to 320 nm, such as from 300 nm – 320 nm, such as from 300 nm – 310 nm.

10. A lamp system according to any of the previous claims, comprising a movement sensor for sensing human movement in a room accommodating the movement sensor, and wherein the light controller is configured for controlling the plurality of light sources in response to the amount of movement sensed by the movement sensor.

11. A lamp system according to any of the previous claims, comprising a personal health sensor configured to be worn by a human and sensing at least one health parameter selected from the group consisting of body temperature, skin conductivity, heart rate, and blood pressure, and wherein the light controller is configured for controlling the plurality of light sources in response to parameter values sensed by the personal health sensor.

12. A lamp system according to any of the previous claims, comprising at least one personal environment sensor configured to be worn by a human and selected from the group consisting of accelerometer, gyroscope, compass, ambient light sensor, UV sensor, GPS-unit, and barometer, and wherein the light controller is configured for controlling the plurality of light sources in response to parameter values output by the personal environment sensor.

13. A lamp system according to any of the previous claims, wherein the light controller has an interface to a network and is configured to be interconnected with a remote server through the network for performing at least one of the operations selected from the group consisting of utilizing computing resources of the remote server to control the

plurality of light sources, access personal data relating to a human using the lamp, and access data relating to the environment of the lamp.

14. A lamp system according to any of claims 10 – 13, wherein at least one of the movement sensor, personal health sensor, and personal environment sensor have a network interface for connection with a remote server for storage of data provided by the sensors.

15. A lamp system according to any of the previous claims, comprising a hand-held unit that is configured for connection to the light controller and has a user interface configured for user entry of user data, and wherein the hand-held unit is configured to transmit the user data to the light controller, and wherein the light controller is configured for controlling the plurality of light sources in response to the user data.

16. A lamp system according to any of the previous claims, wherein the hand-held unit is selected from the group consisting of a smartphone and a tablet and has an interface to a network and is configured to be interconnected with a remote server through the network.

17. A lamp system according to claim 15 or 16, wherein at least a part of the light controller resides in the hand-held unit.

18. A lamp with a lamp housing accommodating a plurality of light sources for emission of visible light, including blue light, that is configured for emission of blue light with a luminous flux ranging from 50 lux to 200 lux at a distance of 3 metres from the lamp.

19. A lamp according to claim 18, wherein the lamp housing is configured for attachment at a frame of a window and wherein each light source of the plurality of light sources is mounted in the lamp housing so that a centre part of the light emitted by the light source is directed towards a part of the frame when the lamp is mounted in its intended position for use, whereby light emitted by the lamp is reflected by the frame of the window for illumination of a room in combination with sunlight entering the room through the window.

20. A lamp according to claim 19, wherein different light sources of the plurality of light sources are mounted in the lamp housing for emission of light along different centre directions of propagation for illumination of different parts of the frame of the window illuminated by sunlight at respective different times during a day.

21. A lamp according to claim 18, wherein the lamp housing is configured for attachment at a frame of a window and wherein different light sources of the plurality of light sources are mounted in the lamp housing for emission of light along different centre directions

of propagation, and wherein each of the different centre directions of propagation is equal to a direction of propagation of sunlight reflected by the frame at a respective time of day when the lamp is mounted in its intended position for use.

22. A lamp according to any of claims 19 – 21, wherein the lamp housing has a surface with an adhesive for attachment at the frame of the window.

23. A lamp according to any of claims 18 – 22, wherein the lamp housing accommodates the light sensor.

24. A lamp according to any of claims 18 – 23, comprising

a time keeping unit,

a light sensor for sensing intensity of light incident upon it, and

a light controller configured for controlling the plurality of light sources in response to the intensity of light sensed by the light sensor and the time provided by the time keeping unit.

25. A lamp according to claim 24, wherein the light controller is configured to control the plurality of light sources to emit light that in combination with the part of daylight having been transmitted through the window has a visible part of the spectrum with a desired shape.

26. A lamp according to any of claims 18 – 25, wherein the lamp housing comprises at least one ultraviolet light source for emission of ultraviolet light, preferably in the UVB range from 280 nm to 380 nm, such as from 280 nm to 320 nm, such as from 300 nm – 320 nm, such as from 300 nm – 310 nm.

27. A lamp according to any of claims 24 – 26, comprising an interface to a movement sensor for sensing human movement in a room accommodating the movement sensor, and wherein the light controller is configured for controlling the plurality of light sources in response to the amount of movement sensed by the movement sensor.

28. A lamp according to any of claims 24 - 27, comprising an interface to a personal health sensor configured to be worn by a human and sensing at least one health parameter selected from the group consisting of body temperature, skin conductivity, heart rate, and blood pressure, and wherein the light controller is configured for controlling the plurality of light sources in response to parameter values sensed by the personal health sensor.

29. A lamp according to any of claims 24 – 28, comprising at least one personal environment sensor configured to be worn by a human and selected from the group

consisting of accelerometer, gyroscope, compass, ambient light sensor, UV sensor, GPS-unit, and barometer, and wherein the light controller is configured for controlling the plurality of light sources in response to parameter values output by the personal environment sensor.

30. A lamp according to any of claims 24 – 29, wherein the light controller has an interface to a network and is configured to be interconnected with a remote server through the network for performing at least one of the operations selected from the group consisting of utilizing computing resources of the remote server to control the plurality of light sources, access personal data relating to a human using the lamp, and access data relating to the environment of the lamp.

31. A lamp according to any of claims 27 – 30, wherein at least one of the movement sensor, personal health sensor, and personal environment sensor have a network interface for connection with a remote server for storage of data provided by the sensors.

32. A lamp according to any of claims 24 – 31, comprising a hand-held unit that is configured for connection to the light controller and has a user interface configured for user entry of user data, and wherein the hand-held unit is configured to transmit the user data to the light controller, and wherein the light controller is configured for controlling the plurality of light sources in response to the user data.

33. A lamp according to claim 32, wherein the hand-held unit is selected from the group consisting of a smartphone and a tablet and has an interface to a network and is configured to be interconnected with a remote server through the network.

34. A method of increasing human work productivity is provided; comprising the step of illuminating the eyes of the human with blue light with a luminous flux at the eyes ranging from 50 lux to 200 lux, preferred from 75 lux to 150 lux, more preferred around 100 lux, for a selected time period.

35. A method according to claim 34, comprising the step of selecting a start time of the time period of illuminating the eyes of the human with blue light that is 24 hours subsequent to a previous start time with a selected time interval added to the previous start time or subtracted from the previous start time, thereby changing the circadian rhythm of the human.

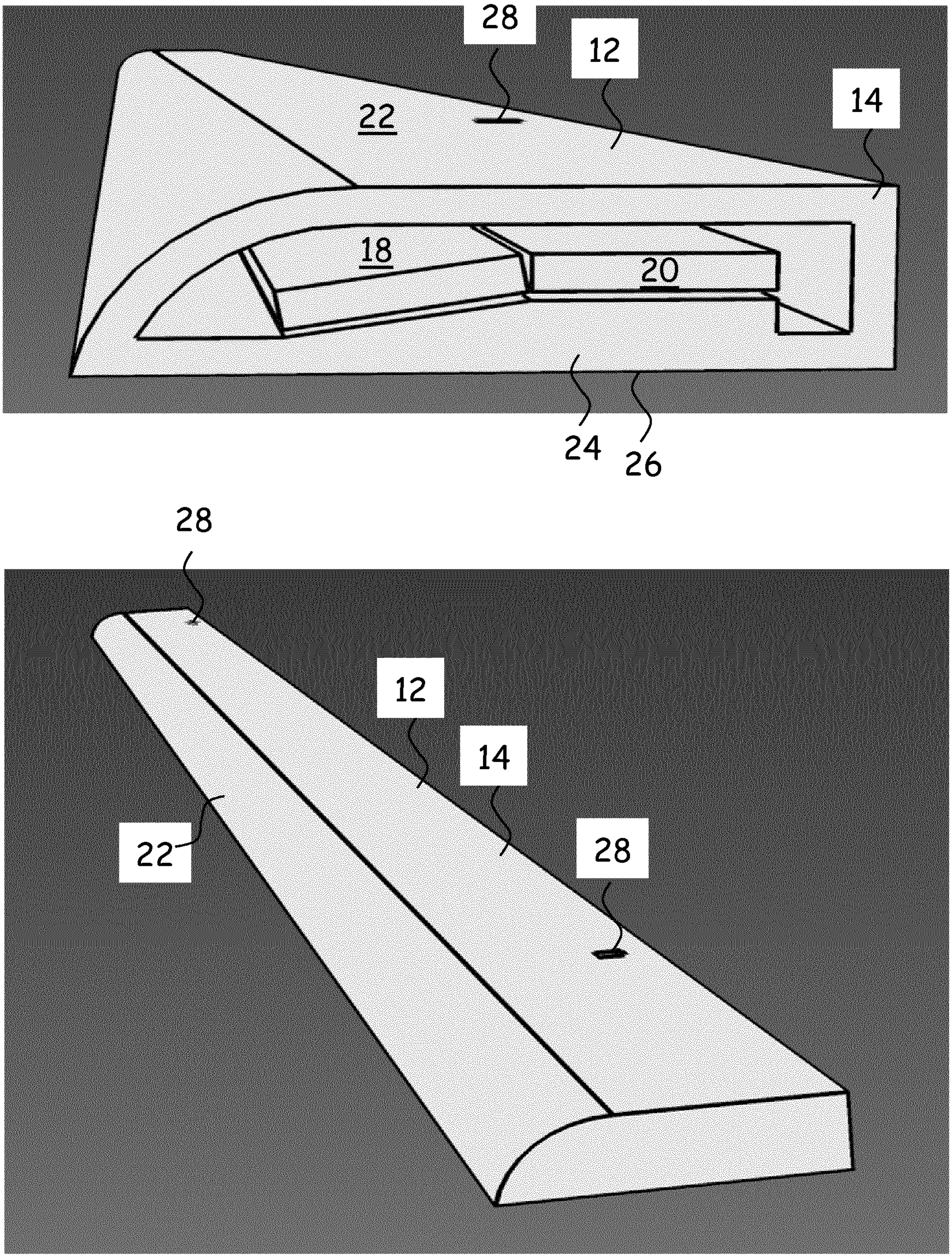

Fig. 1

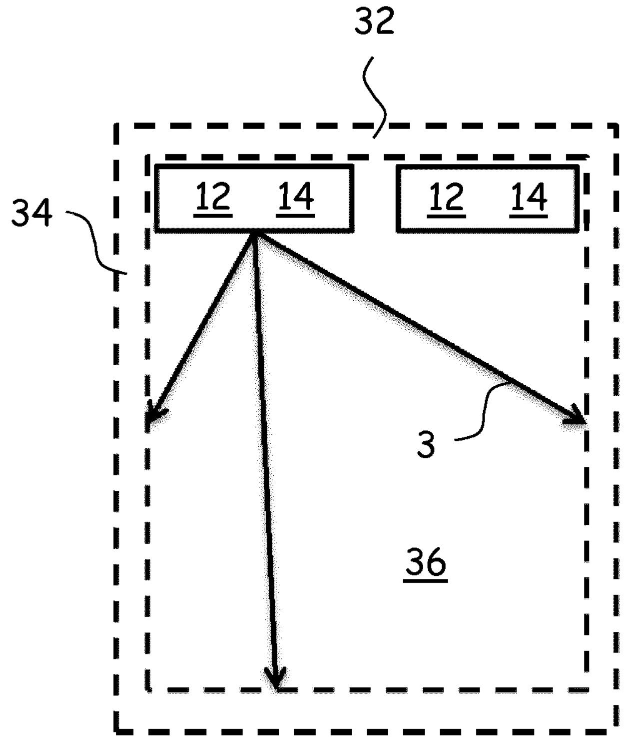

Fig. 2

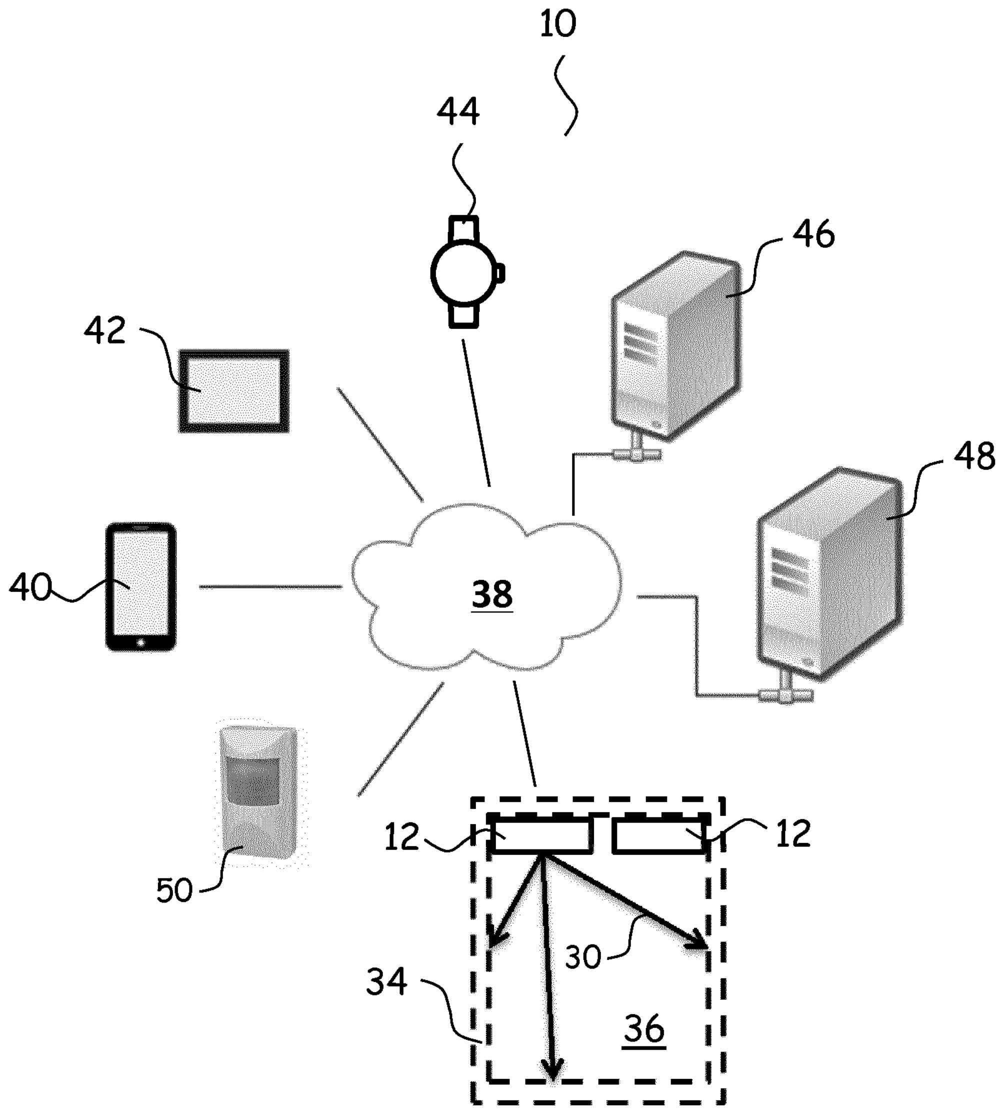

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/061017

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61N5/06
ADD. F21S8/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F21S A61N A61M H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/277105 A1 (OYAMA KAZUYA [JP]) 4 November 2010 (2010-11-04)	1-8,13, 15-25, 30,32-35
A	paragraphs [0023] - [0027], [0074] - [0075], [0080], [0156]; figures 7-12,15,19-21, 28A-B -----	9-12,14, 26-29,31
X	DE 10 2010 030501 A1 (OSRAM GMBH [DE]) 30 December 2010 (2010-12-30)	18,19, 22,34,35
A	paragraphs [0015], [0022], [0030], [0032] - [0042], [0048], [0049]; figure 2 -----	1-17,20, 21,23-33

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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 July 2016	28/07/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Link, Tatiana

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/084614 A1 (EISELE ERIC JON [US] ET AL) 14 April 2011 (2011-04-14)	1-3, 6-19, 22-35
A	paragraphs [0039] - [0048], [0060], [0158] - [0171], [0195] - [0196]; claims 10,13-18; figure 10	4,5,20, 21

X	WO 2014/064587 A1 (KONINKL PHILIPS NV [NL]) 1 May 2014 (2014-05-01)	1,2,9, 10, 13-18, 26,27, 30-34
A	paragraphs [0059] - [0064], [0071] - [0077], [0083] - [0084]; figure 3	3-6,8, 11,12, 19-22, 25,28,29

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A	paragraphs [0013] - [0016], [0020], [0021], [0034]; figures 1,4B,5, 6	1-17,20, 21, 23-25, 27-33

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International application No
PCT/EP2016/061017

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